NATURE STUDY FOR THE GRADES.

WILBUR S. JACKMAN.

THE stress of the winter season taxes the powers of resistance in the living thing to the utmost. The gradually lowering temperature brooks neither excuse nor delay in those preparations which are necessary to insure the safety of the creatures that, but a few weeks before, would have been entirely blasted by a single hour of frost.

It is most natural, therefore, to turn the attention of the pupils, at this season, to the peculiar conditions assumed by living things in the winter, and to study the various protective devices employed by animals and plants. Most of the birds, thanks to that wonderful invention, the feather, have sought safety and comfort in migration; but the insects, the mammals, the earthworms, the plants, and man have each worked out certain plans that enable them to remain on the spot.

To the naturalist the winter is a season for observation not less interesting than the summer. The means adopted by the buds as protection against the season are as interesting as those used in summer by the leaves in seeking the light. The sudden and almost mysterious disappearance of the showers of seeds that lately ripened in enormous quantities is only paralleled by the silent withdrawal of the birds. The mud and slime at the bottom of the ponds and marshes hold a counterpart of the life that swarmed in the water in summer. Under stones, in the cracks of the bark of the trees, and in protected situations on the branches, are the cocoons, the eggs, and other forms of insect life that have developed a strength of endurance of the cold that is utterly beyond the powers of man.

The very first step in the study of these strange and apparently inhospitable life-conditions requires the thermometer, the use of which even the youngest children should learn. With this in hand, they may soon acquire some idea of what must be

endured by the buds on the twigs and by the cocoons swung to the branches; by the seeds in the surface inch of earth; by the roots a foot or more below; by the fishes in the water under the ice; by the seeds and small animal forms in the mud under the water; and, through these observations, they will soon find out within what narrow limits of temperature their own comfort lies.

From a study of life that is subjected to natural conditions only, it is an easy transition to the study of the means used to provide artificial heat and to a consideration of those conditions of life and of those peculiarities of structure and function which make it a necessity. The following outline suggests an order of topics in the study. It is the intention to have each grade, with the guidance of the teacher, select from the entire outline points that may be observed. Experiments should be performed when they are needed to answer some question, and they should come mainly through the inventions of the pupils themselves; otherwise they are liable not to be appreciated, and then they are of doubtful value.

It is of great importance, however, to keep the subject before the pupils in its entirety. True study does not *dissect* a subject, but *defines* it. Thus, the first-grade pupils, learning the use of the thermometer, will become a little better posted as to relative temperatures. By means of a journey over the school they can find out where the radiators are placed and why they are so placed, and, possibly, the number needed. Using smoking paper they can trace some of the air currents, warm and cold. They can note something as to their breathing; note, perhaps, the disagreeable odor of a poorly ventilated room. They can distinguish the different kinds of coal and make some collections. They can tell of the coal cars and coal sheds. If not otherwise practicable, the work of mining, transportation, etc., may be shown by pictures. Different kinds of coal reduced to small pieces and finely divided wood may be burned in a clay pipe or a tin cup, and the ash of each examined and comparisons made. The relation of heat to light may be presented through the heating of a small wire in a flame; when hot

enough, the wire gives light. Finally, a visit to a power-house will show what heat can do as work power. All this is general, to be sure, but what is gained is gotten through observation and by a method truly scientific, and the symmetry and wholeness of the original picture which the child had to begin with will not have been destroyed.

In the higher grades the same ground is covered; many details can be omitted which will give more time for experiments of a more exact character. Whatever the grade may be, there will be abundant demand for expression by the hand, in drawing and color work, in modeling, while almost every step will require the application of number and form. Of course the picture will not be preserved in its completeness unless the pupil is kept in touch with the great underlying causes of the phenomena of winter. The short day, the slanting sunshine, the wind, the frost and snow in place of the dew and rain form the real setting in the minds of the children for all the work that is done. Some form of records of these should be kept. The records should be graphic — not merely of itemized facts among which there are no very obvious relations.

For fuller suggestions the teacher is referred to the author's *Nature Study for the Common Schools;* for details as to experiments, to *Nature Study for the Grammar Grades;* and for related work, to *Nature Study and Related Subjects.*

THE WINTER SEASON.

I. GENERAL EFFECTS.

1. Hibernation of animals.
2. Buds, roots, stems, seeds, etc.
3. Temperature of air; of soil at different depths; in different locations. Use the thermometer.
4. Clothing and covering of animals.

II. HEATING AND VENTILATION.

1. *The school heating plant* (steam).
   - (*a*) Radiators.
   - (*b*) Boilers and pipes.
   - (*c*) Furnace.
   - (*d*) Conduction; convection; radiation; illustrative experiments.

2. *The home heating plant.*
   (*a*) Hot air.
   (*b*) Grates.
   (*c*) Hot water.
   (*d*) Steam.
3. *Effects of heat upon air.*
   (*a*) Air currents.
   (*b*) Openings of rooms, doors, cracks, etc.
4. *Breathing.*
   (*a*) Number of respirations per minute.
   (*b*) Quantity of air breathed.
   (*c*) Qualities of expired air; tests with flame and lime-water.
5. *Mechanics and physiology of breathing.*
   (*a*) Lungs and air passages.
   (*b*) Heart and blood-vessels.
   (*c*) Circulation, pulse, etc.
   (*d*) Effect of exercise as shown in breathing and pulse rate.

III. FUELS.

1. *Kinds used.*
   (*a*) Coal; anthracite, amount needed to heat the home.
   (*b*) Coal; bituminous, amount needed.
   (*c*) Natural gas; amount needed.
   (*d*) Wood; amount needed.
   (*e*) Contrast the properties of different fuels.
2. *Cost of fuels.*
   (*a*) Mining and lumbering. Localities.
   (*b*) Transportation.
   (*c*) Life of people engaged in these industries.
   (*d*) Sources of loss in the production of heat for its practical uses.

IV. NATURE OF FUELS.

1. Experiments to show the per cent. of ash in various kinds of coal and wood.
2. Experiments to show the amount of gas in different fuels.
3. Gas-making; various tests for gases.
4. Sum up the likenesses and differences of the various fuels.

V. HEAT AND LIGHT.

(1) Study of a candle; of a lamp; of a gas flame.
(2) The electric light.

VI. HEAT AS ENERGY.

(1) Study the relation of the boiler to the furnace and the engine.
(2) Its effect upon air; upon liquids; upon solids. Study buildings where iron is used in places subject to changes in temperature; beams that are riveted together.